Faculty of Cognitive Sciences and Human Development

VIDEO GAMES AND WORKING MEMORY PERFORMANCE

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Final Year Project Report [/]
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ABSTRACT

The aim of study was to investigate the relationship between video games and working memory performance among university students by focusing on two categories of video games which is serious and commercial games by conducting a dual task of verbal recall. The first objective of the study was to investigate the differences in the means of correct verbal recall between serious, commercial and no video games group and the second objective was to determine the differences in the means of correct verbal recall between before and after playing video games. The study conducted an experiment with 30 participants that are equally divided into three group which are serious game, commercial game, and no video game group. The serious game and commercial game groups will play Minecraft and Pubg as the intervention for 30 minutes respectively while the no video game group will have no intervention. A pre-test and post-test of results of verbal recall task was recorded. The findings to the first objective utilized one-way ANOVA and found that there were no significant differences of correct verbal recall between serious, commercial and no video game group while the findings to the second objective utilized paired sample t-test and resulted in no significant differences between before and after playing video games. It was discovered that mental states such as attention, motivation, mind-wandering and emotional were factors in the resulting outcomes. Overall, the study had found that there were no differences between the relationship of video games and working memory performance

ABSTRAK

Tujuan kajian adalah untuk mengkaji hubungan antara permainan video dan pencapaian *working memory* dalam kalangan pelajar universiti dengan memberi tumpuan kepada dua kategori permainan video, permainan serius dan komersial dengan melakukan *dual task* iaitu mengingat secara lisan. Objektif pertama kajian ini adalah untuk mengenalpasti perbezaan cara mengingat secara lisan yang betul antara kumpulan permainan video yang serius, komersial dan tiada permainan video. Objektif kedua adalah untuk menentukan perbezaan cara mengingat secara lisan yang betul antara sebelum dan sesudah bermain permainan video. Kajian ini melibatkan 30 peserta yang dibahagikan sama kepada tiga kumpulan iaitu permainan serius, permainan komersial, dan tiada permainan video. Kumpulan permainan serius dan permainan komersil akan bermain Minecraft dan Pubg masing-masing selama 30 minit sementara kumpulan tidak ada permainan video tidak ada intervensi. Ujian pra dan ujian pasca hasil tugas ingat lisan direkodkan. Hasil analisis hipotesis menggunakan ujian ANOVA sehala mendapati bahawa tidak ada perbezaan yang signifikan dari penarikan lisan yang betul antara kumpulan permainan serius, komersial dan tiada permainan video sementara penemuan untuk objektif kedua menggunakan *paired samples t-test* dan mengakibatkan tidak signifikan perbezaan antara sebelum dan selepas bermain permainan video. Selain itu, diketahui bahawa keadaan mental seperti perhatian, motivasi, mengembara minda dan emosi adalah faktor dalam hasil yang dihasilkan. Kesimpulan yang diperoleh dari hasil kajian ini ialah tiada perbezaan antara permainan video dan *working memory performance.*

Table of Contents

List of Tables

List of Figures

CHAPTER 1 : INTRODUCTION

1.1 Introduction

This chapter describes the formulation of this project. This chapter presents the background of the project, problem statement, research questions and objectives, project scope and then project significant.

1.2 Background of study

A growing demand for video games has risen over the years as individuals are replacing traditional games with video games to fill their past time (Baltezarević et al., 2018). Hence, the video gaming industry has grown fast over the past several years and is constantly evolving with the trends. Generally, video games are divided into three platforms which are mobile, computer and consoles. The convenience of these platforms allows the users to have more accessibility to play games at any time of the day and place they want. In Malaysia, 73% of Malaysians between the age of 16 to 24 years old played online games and a large portion of them played daily (• *Malaysia: Online Gamers by Age Group 2020 | Statista*, n.d.). Another survey found that 75% of online gamers play games on mobile, 66% play games on PC and 55% play on console (*Insights into Malaysia's Games Market and Its Gamers | Newzoo*, n.d.).

The reason why many people play video games is because of its interactive features which differentiate it from other mediums of entertainment. One of the reasons people play video games is because they are driven by the flow of experience, they get from playing games that is achieved by engaging with in-game challenges and their skill level in achieving in-game goals (Hsu & Lu, 2003). Another intrinsic motivational factor that drives players to play video games is that it provides players with a sense of control by achieving goals (Ferguson & Rueda, 2010).

With the increased interest of video games, more studies are done in order to find the associations of video games and working memory. Working memory is a system that holds

information in the mind for a brief time while executing mental operation towards the information (Baddeley & Hitch, 1974). It is involved in every thought process in cognitive tasks such as information processing, problem-solving, executive function, intelligence, comprehension and learning (Cowan, 2014). Thus, the relation of working memory and video games is because of the various cognitive thought processes used in video games to achieve the in-game goals (Barlett et al., 2009).

Several cross-sectional studies have been carried out to investigate the associations of video games and working memory that have mostly lean towards the improvement of working memory. For instance, Choi et al. (2020) discusses the modulating factors of cognitive enhancement from video games with reviewing extensive literature by differentiating video games as serious games and commercial games in which serious games refers to video games that are educational while commercial games are for the purpose of entertainment. It was found that enhancement of working memory performance and capacity was shown after extensive playing of commercial video games. Another study that supports the previous dissertation has found that action video games, particularly first person shooting games, resulted in accurate performance of working memory that was measured by n-back task (Colzato et al., 2013).

Dual-task paradigm is a procedure designed to occupy specific working memory buffers by performing cognitive tasks concurrent with various distractor tasks (Oberauer & Kliegl, 2004). It requires participants to simultaneously perform two tasks in which one task is primary and the other is secondary. For example, participants are required to memorize a list of items (the secondary task) while performing the task that is investigated (the primary task). The operations of the tasks have a similar nature of information processing that concludes them to interfere with one another. Several studies have employed this method for investigating working memory (Lee & Kang, 2002; Phillips et al., 2007; Stets & Helton, 2018).

Thus, the study aims to investigate the differences between the types of video games in working memory performance. The study focuses on two categories of video games which is serious and commercial games by conducting a dual task of verbal recall to find the associations with working memory.

1.3 Problem statement

Prior research has widely focused on negative and harmful impacts of playing video games towards individuals as well as having contradictory results of cognitive enhancement from playing video games (Eichenbaum et al., 2014; Özçetin et al., 2019). Moreover, research on working memory for playing video games has shown to have either improvement or no improvement toward working memory performance (Baniqued et al., 2013; Colzato et al., 2013; Kuschpel et al., 2015; Mcdermott et al., 2014**).** Therefore, a more balanced and clearer study of playing video games on working memory is needed to produce accurate results.

Furthermore, previous research is largely focused on action video games as the variable in investigating cognition of working memory whereas other video games were less studied (Colzato et al., 2013; Dye et al., 2009; Green & Bavelier, 2003; Kuschpel et al., 2015). This is most likely because action video games are fast paced and require intuitive decision making. As such, this study will be using the leisure game and educational games to evaluate working memory.

In addition, most studies on video games and working memory were centralized around western culture especially from the United States as compared to carrying it out in Malaysian contexts. When applying it to the Malaysian context, the findings can differ as there are cultural differences between the countries. Besides, exposure of playing video games in Malaysia is also different as most students play accessible and easily obtainable games while westerners can have access to more options of games.

1.4 Objective

1.4.1 General objective

To investigate the differences between types of video games in working memory performance.

1.4.2 Specific objectives

1. To investigate the differences in the means of correct verbal recall between commercial, serious and no video games group.

2. To determine the differences in the means of correct verbal recall between before and after playing video games.

1.5 Research questions

1. Is there any difference in the means of correct verbal recall between commercial, serious and no video games group.

2. Is there any difference in the means of correct verbal recall between before and after playing video games?

1.6 Conceptual framework

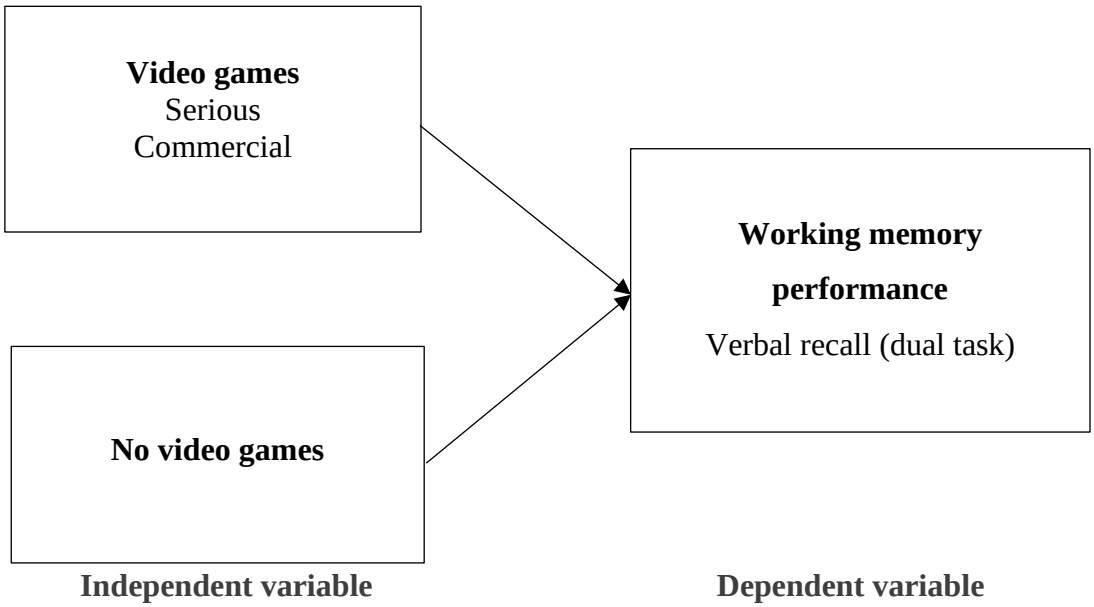


Figure 1.1 Conceptual framework of relationship between video games and working memory.

1.7 Research Hypothesis

H_1: There is no significant difference in the means of correct verbal recall between commercial, serious and no video games group.

H_2: There is no significant difference in the means of correct verbal recall before and after playing video games.

1.8 Definition of terms

1.8.1 Video games.

According to Juul (2010), video game is defined as a computer-processing power using a rule-based system that is interactive with its audience. It involves a constant exchange of interaction between the player and game, thus having variable, quantifiable and differentially volarized outcomes.

In this study, the operational definition of video games refers to the different type of video games tested which are serious games and commercial games that are Minecraft and PlayerUnkonwn's Battleground (PUBG) respectively.

1.8.2 Working memory performance.

According to Baddeley & Hitch (1974), working memory is a multi-part system which is split into three main components which are the central executive, the phonological loop and the visuo-spatial sketchpad. Each component has different function and act independently of one another.

The operational definition of working memory in this study is a set of processes that hold and store information as well as manipulate information to execute complex cognitive tasks which can be measured using verbal recall task which refers to the number of correct words recalled by the participants in the verbal recall tasks.

1.9 Significance of the study

This project aims to investigate the impact of playing video games on working memory in adults. It will give a deeper understanding to individuals on the extent of improving their memory capacity. The study will give further explanation and exploration of video games and working memory to aid in future research. Besides, it can encourage game developers to create video games that can enhance their cognitive abilities with specific integrated elements.

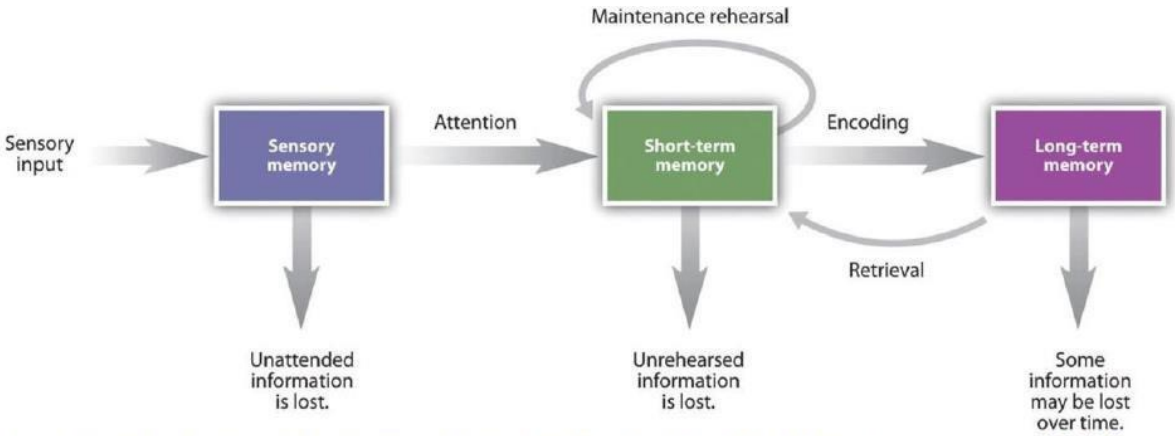
CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

In this chapter, a wide range of literature on views and research relating to the research topic is evaluated. The first section discusses the theories relating to the study. The second section is regarding research on video games, cognitive abilities and working memory. The third section discusses the issue on the importance of defining the type of video game used in research.

2.2 Theoretical Framework

The theory that supports the basis of this study is information processing theory. The premise of the theory is that the human mind acts as a computer and information processor (Miller, 2003). It compares the human mind to a computer in the way that it receives input, processes, and delivers output. The 'input' is information gathered from the senses, which is then stored and processed in the brain, and finally the 'output' is the resulting behavioural response. The theory describes how the first stage is perceiving information through sensory memory, stores it into short term memory and ultimately enters long term memory. According to this theory, exposing oneself to more video games will increase the likelihood of retaining information to long term memory. With this method, video games are training the brain to make judgments and inferences based on the tasks. According to Ang (2006) video game has the basic operation of including gameplay, narratives and rules to achieve the goals of the game. By repeatedly providing the brain with sufficient backgrounds and material, it can make connections and optimizes the possibility of the information to be retained in long-term memory. The figure below shows an adapted version of information processing theory.



Memory can be characterized in terms of stages—the length of time that information remains available to us.

Source: Adapted from Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. Spence (Ed.) *The psychology of learning and motivation* (Vol. 2). Oxford, England: Academic Press.

Figure 2.1 *According to the Atkinson-Shiffrin model of memory, information passes through three distinct stages in order for it to be stored in long-term memory.*

2.3 Working memory

The term "working memory" has been discussed and deliberated about among scholars since the 1960's. Working memory was first introduced as a term by Miller, Galanter, and Pribram (1960), in a book but was not properly elaborated. It was then described by Atkinson & Shiffrin in 1968, as a short-term memory that serves as a gateway by which information can gain access to long-term memory. It has also been associated with the information processing theory. Eventually, scholars Baddeley and Hitch took great interest in the study and revised the concept of working memory that is most represented in this generation.

In 1974, Baddeley and Hitch proposed a multicomponent model of working memory. The theory suggests that working memory is a multi-part system which is split into three main components which are the central executive, the phonological loop and the visuo-spatial sketchpad. Each component has different functions and acts independently of one another. Compared to Atkinson and Shiffrin's model, it consists of two short term stores that is the central executive and a control system that are the phonological loop and visuo-spatial sketchpad. It is presumed that the central executive is the most important as it governs

integration and coordination of information for the two subordinate systems. One subordinate system, the phonological loop, stores information based on verbal expression and sounds in which it can be maintained by subvocal rehearsals to oneself while the other subordinate system, the visuo-spatial sketchpad, holds visual and spatial information. Furthermore, in 2000, Baddeley further adds to the theory a fourth component of the modal which is the episodic buffer. It is a temporary store of limited capacity that has multiple dimensions to allow it to combine information from the visuospatial, perception, verbal subsystems, and long-term memory. It does so by representing them as episodes and will require conscious awareness to retrieve the information. In short, the episodic buffer resembles a stage in which everything happens or a screen that projects events. As such, the components interact with each other to impart a workspace for cognitive activity.

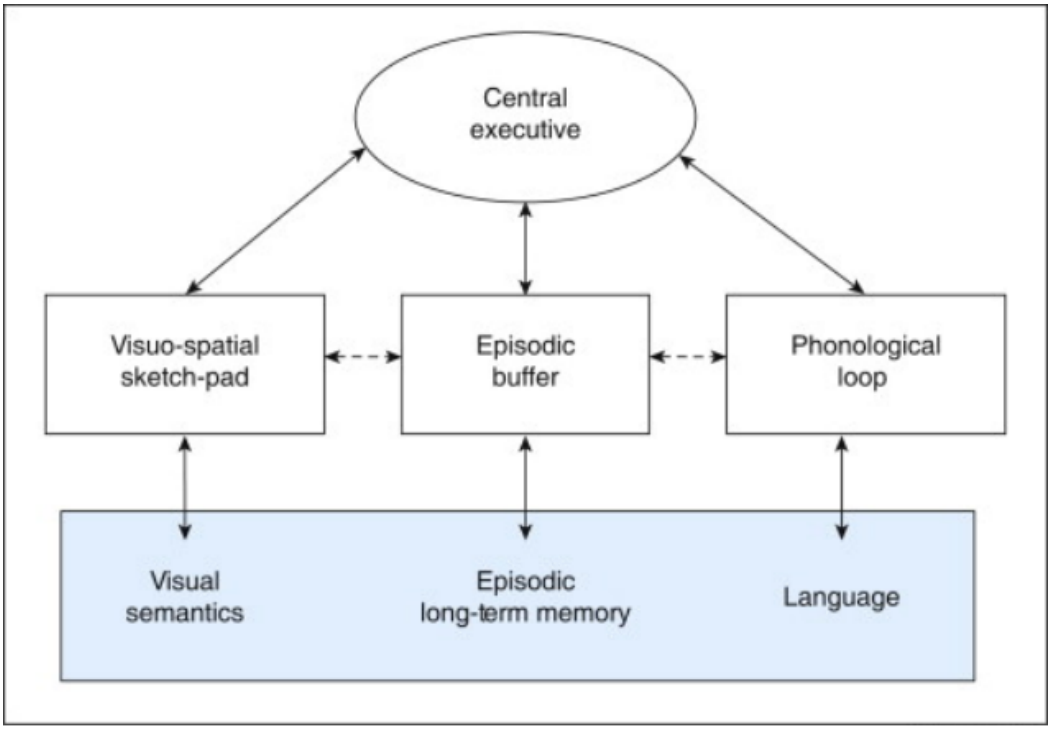


Figure 2.2 *Multicomponent modal of working memory. (Baddeley, 2000)*

Several contributions to working memory have been made and the first was from George Miller in the 1960s in which he discusses the limitations of how many items can be

stored in immediate memory. He proposes three key aspects which are limited capacity, limited duration and encoding. In the relevant test procedure, capacity is measure by span or recency effect. The following resulted in showing that limited capacity stores seven chunks, in which a chunk is a meaning unit. Thus, the idea of Magic Number Seven Plus Minus Two was put forward and is one of the contributions to working memory.

Moreover, a footnote in Donald Broadbent's 1958 book introduced an information processing diagram that is known as Broadbent's filter model. It described information progressing from a sensory store that briefly retain information, through a selective attention filter to essentially a working memory that can hold several items and eventually to the long-term memory that stores experience and knowledge gained through a lifetime. The foundation of his work was formed based on his research with selective attention, including his dichotic listening studies whereby the task was listening to a message from one ear and ignoring the message with the other ear, or report both messages in some order to input into the sensory store. His work was important in the discovery of a longer-lived but small capacity abstract working memory that required attention.

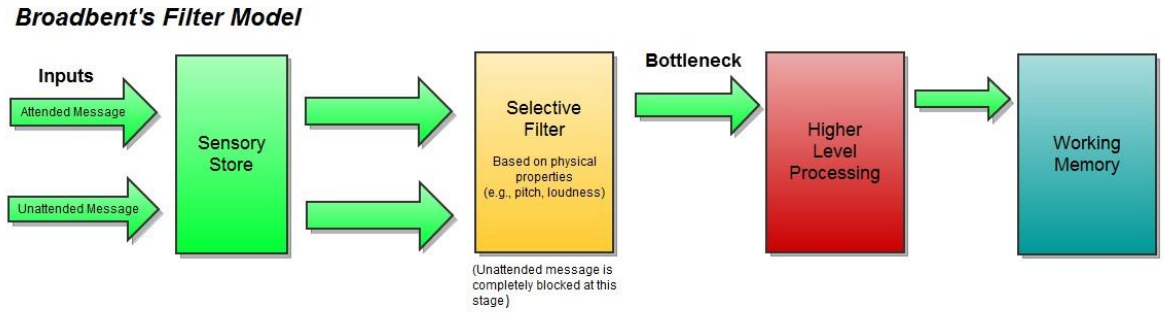


Figure 2.3 *Broadbent's Filter Model.*

In the late 1960's, the emergence of Atkinson and Shiffrin (1968) theory of the multi-store model of memory which is also known as the modal model of memory (Malmberg, Raaijmakers, & Shiffrin, 2019) is an elaborated version of Broadbent's (1958) model. The

model describes memory by dividing it into three main types of storage which are a sensory register, short-term memory (STM) and long-term memory (LTM). The model starts by having incoming sensory information enter the sensory register in which the information is store there temporarily before decaying. Then, the short-term store receives selected inputs from both the sensory register and long-term store. This shows that there is a continuous flow of information between short-term memory and long-term memory (Malmberg et al., 2019). However, the multi-store model of memory is criticized as it emphasizes the structure of working memory while overlooking the processes. The figure below shows the Atkinson and Shiffrin (1968) modal model of memory.

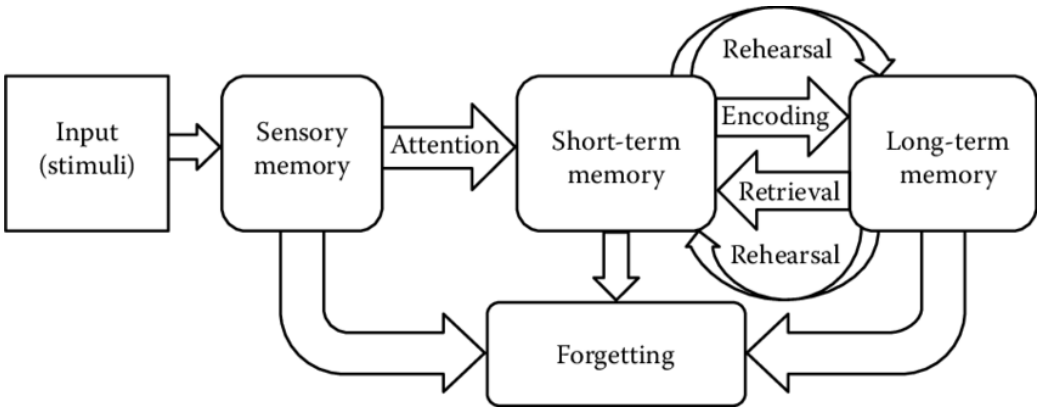


Figure 2.4 *Atkinson and Shiffrin modal model of memory (1968).*

Over the years, several other proposals have been mentioned that are alternatives to the concept of the working memory proposal. One of the alternatives that was most consistent and reliable was Cowan's theoretical framework of working memory in which working memory is described as cognitive processes that retain information in an unusually accessible state. Cowan's model presents that activation takes place in long-term memory temporarily and will dissipate if not maintained by verbal rehearsal or continued attention. Within the activation, a smaller subset highlights the focus of attention, in which it suggests that there is a about a four-item limit or chunks.